souri, 29, 30, 31. Montana, 5, 6, 20, 25. Nebraska, 6, 7. Nevada, 18, 20, 26. New Hampshire, 15. New Jersey, 14, 24, 31. New Mexico, 20, 27, 31. New York, 13, 14, 15, 17. North Dakota, 7. Ohio, 13, 14, 31. Pennsylvania, 13, 14. South Dakota, 7, 8, 28. Utah, 31. Washington, 21. Wisconsin, 13, 30. Wyoming, 28.

WIND.

PREVAILING DIRECTIONS.

The prevailing winds for October, 1894, viz, those that were recorded most frequently at Weather Bureau stations, are shown in Tables I and VIII; they are not given on Chart II, as has hitherto been the custom, but the resultant winds are published instead.

RESULTANT WINDS.

The resultant winds for the current month, as deduced from the hourly readings of self-registers at about 67 regular Weather Bureau stations, are given in Table VIII. Other resultants, deduced from the personal observations made at 8 a. m. and 8 p. m., are given in Table IX. These latter resultants are also shown graphically on Chart II, in connection with the isobars based on the same system of simultaneous observation; the small figure attached to each arrow shows the number of hours that this resultant prevailed, on the assumption that each of the morning and evening observations represents one hour's duration of a wind of average velocity; these figures (or the ratio between them and the total number of observations in this month) indicate the extent to which winds from different directions counterbalanced each other. The original north, south, east, and west components are given in detail in Table IX.

During October the resultant movement was generally from the northwest in New England and on the south Pacific coast; from the southwest in the Ohio Valley and Tennessee, lower Lakes, upper Lakes, upper Mississippi, Missouri, middle Pacific coast region, and middle slope; from the northeast in the south Atlantic States and Florida, and southeast in the west Gulf States and northern plateau region.

HIGH WINDS.

Maximum wind velocities of 50 miles, or more, per hour were reported at regular stations of the Weather Bureau as follows (maximum velocities are averages for five minutes; extreme velocities are gusts of shorter duration, and are not given in this table):

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
		Miles.				*Miles.*	
Amarillo, Tex	1	50	w.	Fort Canby, Wash	27	50	se.
Atlantic City, N. J	10	54	e.	Do	28	53	e.
Block Island, R. I	10	84	e.	Do	29	55	se.
Do	25	62	ne.	Do	31	55	se.
Do	26	68	ne.	Hatteras, N. C	10	60	sw.
Cape Henry, Va	9	66	ne.	Jacksonville, Fla	9	62	se.
Do	28	62	ne.	Kittyhawk, N. C	9	58	se.
Cheyenne, Wyo	1	54	w.	Do	10	58	sw.
Cleveland, Ohio	11	62	w.	Nantucket, Mass	10	54	se.
El Paso, Tex	27	50	sw.	Pensacola, Fla	8	68	ne.
Fort Canby, Wash	2	60	se.	Sioux City, Iowa	25	50	nw.
Do	19	53	se.	Tatoosh Island, Wash	23	54	e.
Do	21	64	se.	Woods Holl, Mass	10	60	sw.
Do	24	70	se.	Do	31	58	sw.
Do	25	72	se.				

LOCAL STORMS.

Destructive or severe local storms were reported as follows:

1st.—Wichita, Kans., windstorm.

2d.—Little Rock, Ark., tornado; 4 persons killed, 26 injured.

3d.—Vicksburg, Miss., thunderstorm.

4th.—Boston, Mass., thunderstorm.

6th.—Jennings, Kans., thunderstorm.

9th.—Columbia, S. C., windstorm.

13th.—Friendship, N. Y., thunderstorm. Brinton, Pa., windstorm.

16th.—Bronson, Mich., cattle killed by lightning.

20th.—Alta, Hopeville, and Ovid, Iowa, windstorms. Kansas City, Mo., and Winfield, Kans., thunderstorms. Hallock, Minn., and Carlisle and Grafton, N. Dak., 1 person killed by lightning at each place.

21st.—Fort Canby, Wash., thunderstorm.

25th.—Near Louisville, Ill., thunderstorm.

26th.—Wilmington, N. C., hailstorm.

28th.—Coushatta, La., hailstorm.

THE TORNADO AT LITTLE ROCK, ARK., OCTOBER 2.

The tornado that occurred at Little Rock, Ark., on October 2, has a special interest from the fact that it is the first case in which the center of the tornado passed immediately over a Weather Bureau station and left a well-marked record on the self-registering instruments. A facsimile of the barometric trace is reproduced on Chart I, and the following account is quoted verbatim from the report of Mr. George S. Harkness, Weather Bureau observer at that station:

During the day the sky was obscured by a stratum of light gray clouds, gentle southwesterly winds prevailed, and the thermometer was a little above the normal for the season.

About sunset the clouds changed to cumulo-stratus in the west, and lightning began to play. By 6 p. m. the play of the lightning was almost continuous; it was not observed in flashes, but rather by reflection from above the bank of gathered clouds; the temperature rose perceptibly, but was not ominously oppressive. These conditions prevailed until about 7.55 p. m., when light, spitting rain began to fall.

At the time of the regular afternoon observation the cloud conditions were about as follows: Apparently the clouds were all nimbus, the rain being as described, light, but the drops were large. In the west there was a stratum of light gray clouds, above which was a dark series of two or three clouds, making an appearance like points of lace, very deep slate at the base and becoming a lighter coloring and thinner at the extremities. The base was in the west and the clouds pointed to the east. Directly overhead the clouds were of cumulo-stratus formation, and were in a state of violent agitation without any well-defined direction, though apparently moving with the mass from the south.

The thermometer at the observation registered 78; the barometer, corrected, 29.66; the wind, 14 miles per hour from the south; humidity, 77, which was low considering the conditions; and the dew-point was 70.

The conditions were such as have often been observed at this place in case of violent thunderstorms, and this section never having experienced a tornado, your observer was not prepared for the character of the storm which followed.

The first evidence of the storm is shown about two miles west of the city, apparently originating there. The storm cloud moved from the south to the north for half a mile, then, describing an angle, continued its course from southwest to northeast till it reached the Insane Asylum, which is on the western border of the city. The damage done up to this time was very slight, a few trees being uprooted or snapped off, a frame barn, a small frame house, and a few smaller buildings damaged to a greater or less extent, the width of the path varying from a few feet to 200 yards, and the storm cloud only touching the earth at intervals. The ground here is rather low and rises gently toward the east, the Insane Asylum being situated on the crest of this rise. Owing to its exposed position, the large buildings of this institution suffered great damage from the fury of the storm. For the space of 50 feet the east wall of the south wing, which was three stories high, was blown off completely, falling outward toward the east as though the force exerted was from inside, as is often the case with storms of this character. Describing the south side of the storm's path as the right side and the north side as the left side, this wall was nearly the center of the path. Another building on the right side was damaged to some extent. The main entrance on the left side was almost completely ruined, and directly at the entrance Dr. Ingate, the asylum physician, was killed by an iron ornament being torn from the roof and falling through the three floors to the ground floor, where he was at the time.

The direction in which the débris lay upon the ground indicated the spiral movement of the wind in the storm cloud. The asylum fence 100 yards from the building was in the storm's path. The fence was probably 200 yards long,

and was divided almost in the center, the right half lying nearly toward the east and the left half toward the west.

Here the cloud lifted and did no further damage for a distance of half a mile; this distance included a valley. On the rising ground beyond the valley two houses were twisted upon their foundations, the east wall of a frame house being torn out. Dropping into a narrow valley at the other side of this rising ground, the storm executed one of its most remarkable freaks. First tearing away a small frame addition to the east side of a building, then lifting the house proper (which was a frame building) a distance of 15 feet, setting it down, then tearing off the four walls and the roof, destroying and scattering them about and leaving the floor where it lay with the four occupants in the center of the room unharmed.

Continuing through the woods, dropping down and rising at short intervals, a particularly good opportunity was afforded for observing the movement of the wind by the direction in which the large pine trees fell. The direction in which they lay was in accordance with the established theories in regard to the circular motion of the air. In the center of the path trees lying three or four feet apart were pointed in directly opposite directions.

The cloud continued along a hilly stretch of country, doing some damage here and there, until it reached the penitentiary buildings. Portions of these were leveled to the ground and the buildings very generally damaged. At the Penitentiary the direction of the cloud changed a little toward the north for one block and followed up Third street, unroofing some of the small houses in the neighborhood, breaking the glass, and otherwise destroying property. Further along Third street the better residence portion of the city was reached, and a great deal of damage done.

At Izard street the storm again changed to the north for one block and moved east on Second street to Louisiana street, the path widening now and then, indicating the closer approach of the cloud to the earth.

Reaching the business portion of the city, the character of the damage became peculiar in the extreme. Large buildings were passed by unharmed and smaller buildings were chopped off and leveled on all sides. Cornices and roofs were blown from buildings for a distance of 100 yards from the right extremity of the storm.

At Scott street the cloud lowered and reached north to Markham street, including the telegraph office, where your observer was at the time, and the Weather Bureau office.

In the telegraph office the first signs of the approaching storm was a gale from the northeast, accompanied by a very heavy rain and vivid lightning. In almost a second the building on the south side of the telegraph office, which is one story higher, was cut off one story, and this was thrown upon the office building. The storm struck the Weather Bureau office at 8.28 p. m., and consumed probably a minute in passing. The instrument shelter was blown away, together with board walks and platform. The wires connecting the instruments on the roof with the self-recording apparatus in the office were broken and the anemoscope thrown down and partly broken. The windows in the office were blown in and office and furniture drenched with rain. The rain gauges and sunshine recorder were untouched. The barograph in the office recorded a fall of 0.38 inch in the second consumed by the storm in passing. The tank at the gas works, a little distance to the northeast, was raised by this diminution of pressure and the lights throughout the city went out. As soon as the cloud passed the tank settled, the pressure was resumed, and the gas jets could be lighted.

The storm continued down Markham street, doing more damage on the right than on the left side of its path, and disappeared in the river at the foot of Ferry street, no indication of its passage being found east of this point.

The total length of the path was probably 5¼ miles. The shape of the cloud could not be determined, owing to the inky blackness of the night, but there are a few persons who report having noticed a distinct funnel shape. As evidenced by the distribution of damage done along its course, the storm had two distinct motions, a swaying one from side to side and a bounding motion.

[Remarks by the Editor.]

The small diagram on the side of Chart I gives a copy of the oscillations of the barometer, as recorded on the Richard barograph, alluded to by the observer in the preceding description. It will be observed that after a slight oscillation the record drops in a straight line from 29.31 to 28.93 and returns so quickly that the horizontal movement of the barograph sheet or its time scale is not sufficiently open to give any indication of the length of time consumed in this fall and rise. The appearance of the record would be about the same whether the movement of the pen down and back occupied one minute or one second. The statement of the observer is to the effect that "the storm struck the office of the Weather Bureau at 8.28 p. m. and probably consumed a minute in passing, and the barograph recorded a fall of 0.38 inch in the second consumed by the storm in passing."

In giving a proper interpretation to this fall of 0.38, we are confronted with the difficulty of deciding between two equally plausible and probable explanations, viz:

1. If this storm was essentially a rapid whirl about an axis that was vertical or highly inclined to the earth's surface, then theory shows that there must have been a large barometric depression in the central portion of the whirl; the pressure would fall very rapidly as the violent winds approach the station, remain low while the center is passing over, and rise rapidly as the opposing violent winds strike the station. If all this happened within a minute, the barographic record would be similar to that here given, and the minimum recorded pressure would correspond closely to the actual pressure existing in the comparatively quiet central region of the whirl. The fact that the central low pressure occupied nearly a minute in passing over would give the Richard barograph ample time to overcome its sluggishness and adjust itself to the proper minimum reading. In this case also a continuous record of the wind would show its original rapid increase in strength, then a calm period, and then the sudden violent wind from an opposite direction; but, unfortunately, at Little Rock, on the present occasion, the anenometer was destroyed.

2. If the destructive winds were not blowing in a circular whirl, but were simply heavy blasts coming successively from several directions, then the first winds felt at the station were felt as gales, which rapidly increased into violent gusts, but the direction from which these gusts came was not necessarily the same. Apparently at the Weather Bureau station a gale from the northeast was suddenly followed by a gust from the south, which threw the upper portion of the telegraph office northward upon the Weather Bureau building, both of which were included in the so-called tornado cloud. This southerly wind must have been the more violent of the two, and the report states that the "windows in the Weather Bureau office were blown in and the office and furniture drenched with rain." Under these circumstances we must remember that every strong wind produces an increase of pressure on the windward side of an obstacle and a diminution of pressure on the leeward side. The difference between these two pressures is the resultant that tends to push the object along. A chimney top may be so arranged that a wind from any direction will produce a very great diminution of pressure within the chimney flue, by virtue of which the air in the room below flows up through the chimney, leaving a lower pressure in the room itself.

The office room containing the barograph at Little Rock seems to have been so placed that the building was to the leeward of the telegraph and higher buildings during southerly winds. The first wind from the northeast shifted suddenly to a destructive southerly wind, which first threw the roofs of the higher buildings on to the Weather Bureau office and then broke in the windows of the office. In this rapid succession of events the pressure at the barograph was rapidly falling under the influence of the suction up chimney, when it was suddenly raised by the bursting in of the window. Both the fall of pressure within the room and its sudden rise were therefore due entirely to the action of the wind on the building considered as an obstacle, as explained at page 142 of the Treatise on Meteorological Apparatus and Methods. The fall of pressure shown by the barograph would, in this case, represent only what occurred within the room, and have nothing to do with the pressure in the free atmosphere.

The relation between wind and pressure can be best studied when the records are all on the same sheet, so that there may be no uncertainty with regard to the moments of time.